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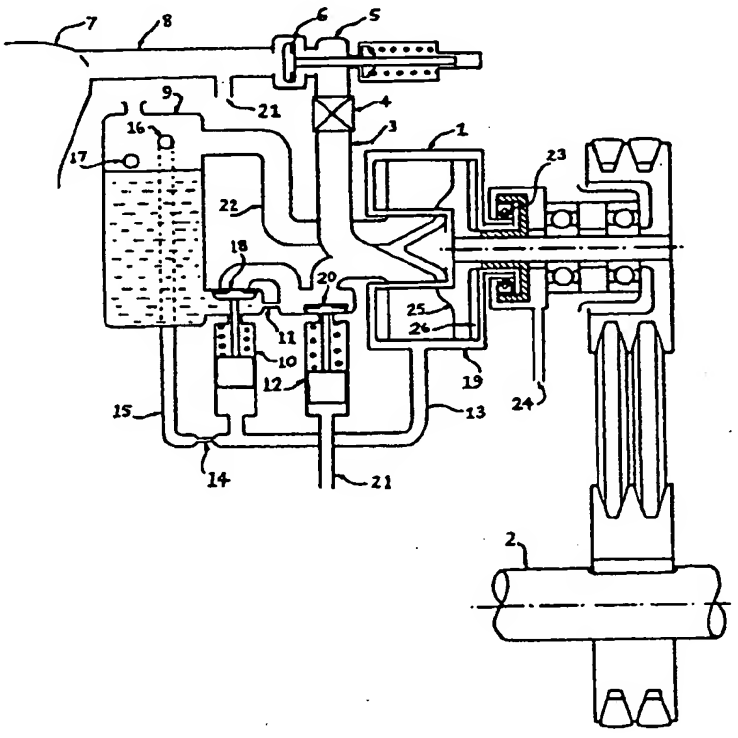
(54) Self-priming centrifugal pump

(57) A continuously driven liquid ring pump 1 communicates with a non-return valve 4, a priming valve 5 and centrifugal pump 7. During the priming process the liquid ring pump contains sufficient liquid in the casing 19 to form a fully developed liquid ring but on completion of the priming process it is arranged for the liquid ring pump to pump out liquid ring fluid into a reservoir 9 and thereby run substantially dry. Should the centrifugal pump lose its prime, liquid from the reservoir is quickly readmitted through a rapid fill valve 10 and coolant circulation valve 20 into the liquid ring pump and the priming action re-established.



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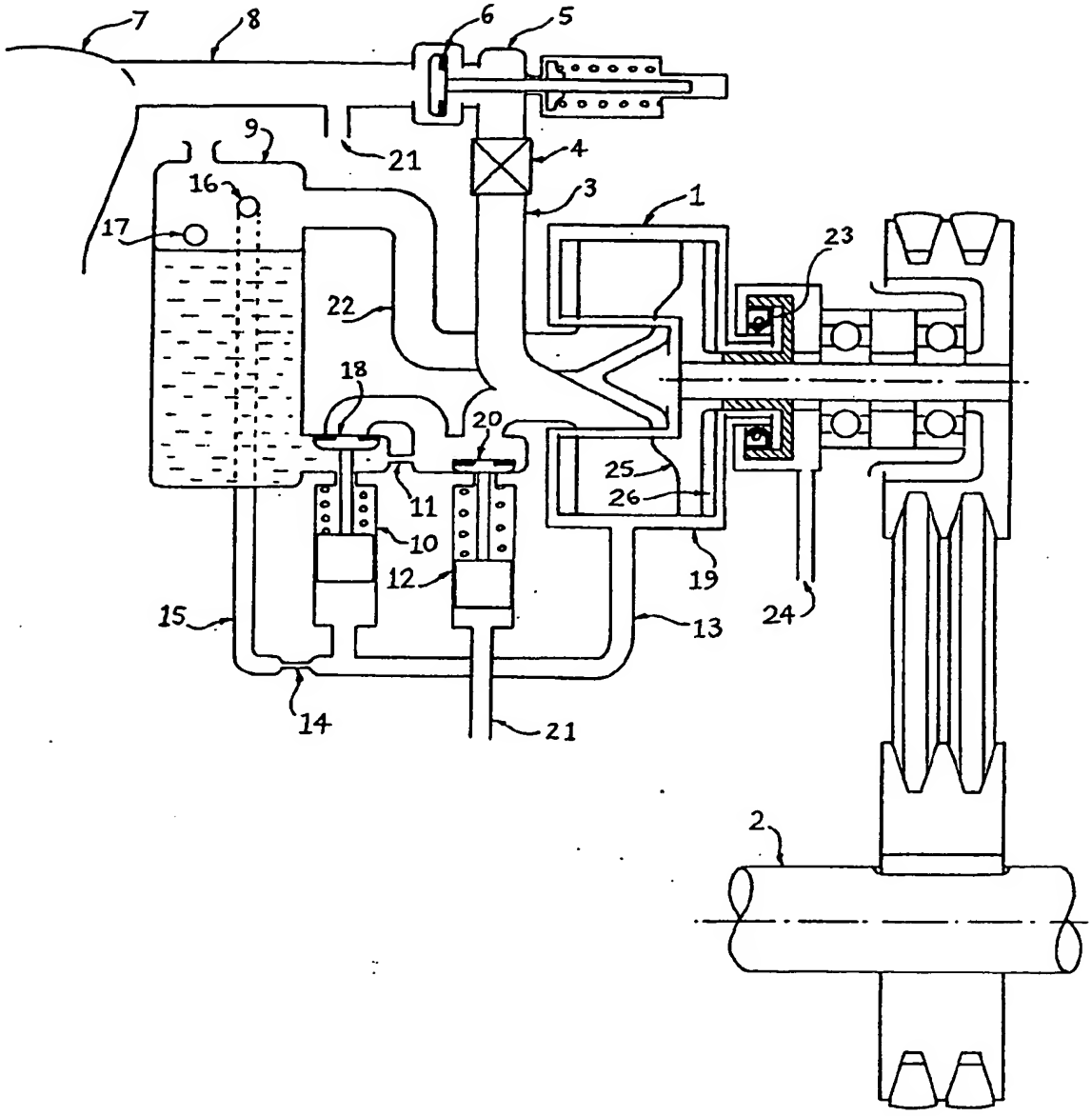

SPECIFICATION

Self priming centrifugal pump

This invention relates to self-priming centrifugal pumps.

Conventional centrifugal pumps are not self priming because when dry the centrifugal impeller is unable to expel air from the pump casing and therefore unable to create suction at the inlet.

One way of overcoming this difficulty is to provide for a secondary vacuum pump whose purpose is to evacuate all the air from the suction pipe and centrifugal pump casing. Such a combination of centrifugal pump and vacuum producing device is well known. For example, in the field of fire fighting or marine engineering where the pumped fluid is water, the vacuum producing device frequently used is a liquid ring pump.

On completion of the priming process, the liquid ring pump is no longer required and it is usual to save unnecessary power consumption either by disconnecting the drive, for example by declutching or separating a pair of friction drive wheels, or by providing for a float mechanism which prevents entry of primed water into the liquid ring pump and connects the inlet of the liquid ring pump to atmosphere.

The disadvantage with the first type is that clutch and friction type drives can be both expensive and unreliable whilst the disadvantage with the second type is that power continues to be absorbed and the heat thereby generated in the liquid ring must be dissipated.

In a preferred embodiment of the invention there is provided a continuously driven liquid ring pump which communicates with a priming valve and centrifugal pump. During the priming process the liquid ring pump contains sufficient liquid to form a fully developed liquid ring but on completion of the priming process it is arranged for the liquid ring pump to pump out liquid ring fluid into a reservoir and thereby run substantially dry. Should the centrifugal pump lose its prime, liquid from the reservoir is quickly readmitted into the liquid ring pump and the priming action re-established.

A specific embodiment of the invention will now be described by way of example with reference to the accompanying drawing.

A liquid ring pump 1 continuously driven from centrifugal pump shaft 2 is fitted with an intake tract 3 which communicates with a non-return valve 4. A priming valve 5, incorporating a closure member 6 resiliently urged to the open position, communicates with the outlet of a centrifugal pump stge 7 through a priming pipe 8. The non-return valve 4 permits fluid flow from the priming valve 5 to the intake tract 3 but not in the rev rse direction.

A reservoir 9 supplies the liquid ring pump with liquid which is arranged to flow through a rapid fill valve 10, a resistive port 11 and a coolant circulation valve 12. A tract 13 is provided which directs liquid through a resistive port 14, through a further tract 15 and back into the reservoir 9. The outlet 16 of tract 15 is arranged to be above the level of liquid in the reservoir by virtue of a suitable overflow tract 17.

The rapid fill valve 10 is provided with a closure member 18 which is resiliently urged to the open position. Valve closure is effected when the liquid pressure in the liquid ring pump casing 19 rises to a predetermined level. The liquid pressure in the casing 19 is conveyed to the valve through tract 13.

The coolant circulation valve 12 is provided with a closure member 20 which is resiliently urged to the open position. The outlet pressure of a centrifugal pump stage 7 is conveyed to the coolant circulation valve 12 by means of priming pipe 8 and tract 21.

The liquid ring pump 1 is fitted with an outlet tract 22 which is ducted to the reservoir 9. It is also fitted with a rotating rubber lip seal 23 and drain passage 24. THe rotor 25 incorporates integral back vanes 26.

Before the engagement of the power source to the shaft 2, the reservoir 9 is filled with liquid to the point of overflow through tract 17. Both the rapid fill valve 10 and the coolant circulation valve 12 will be in the open position thus allowing liquid to quickly flow into casing 19.

On engagement of the power source to the shaft 2 the liquid ring pump rotor establishes a ring of liquid and dispels excess liquid through tract 22. The pressure of the liquid ring closes the rapid fill valve 10 and continuously circulates liquid back to the reservoir back through outlet 16. The circulated liquid is replaced by liquid drawn through the resistive port 11 and coolant circulation valve 12 and into the casing 19. By this means the liquid which forms the liquid ring does not overheat during the priming process.

The partial vacuum which is established in the intake tract 3 draws air from centrifugal pump system through the priming valve 5 and non-return 4. When all the air has been so drawn, the rising pressure developed by the centrifugal pump in the outlet stage 7 begins to pump water through the priming valve. The axial load on the valve rod 27 increases on account of both an increased volumetric throughput and an increased fluid momentum thrust. It will be appreciated that the momentum thrust will be substantially increased owing to the difference in specific gravity of air and water. The geometry of the priming valve is arranged so that the increas d axial load on the valve rod is suficient to close the valve and prevent further water being pumped through to the liquid ring pump. This is the point at which the centrifugal pump is consi-

dered to be primed.

The geometry of the coolant circulation valve 12 is also arranged to close at a substantially similar pressure to that producing closure of the priming valve 5. By this arrangement liquid flow from the reservoir back into the casing 19 will cease but the liquid ring pump will continue to pump out liquid from the liquid ring back to the reservoir until such time as it will run substantially dry. In consequence very little power will be absorbed by the continuous drive.

It will be appreciated that as the casing 19 is evacuated in the manner described above, the pressure produced by the liquid ring will reduce and allow the rapid fill valve 10 to open.

Should the centrifugal pump lose its prime whilst running, outlet pressure from the centrifugal pump falls thus causing the coolant circulation valve 12 to open and admit liquid from the reservoir into the casing 19. The falling outlet pressure from the centrifugal pump also enables the priming valve to open. By this arrangement the liquid ring is re-established and the priming action commenced, thus providing an automatic means of self priming. When the centrifugal pump has been reprimed the liquid ring fluid is pumped out again as described above.

It will be appreciated that the starting torque of the liquid ring primer as described is appreciably lower than arrangements incorporating clutches or friction drives because liquid is admitted into the casing 9 whilst the rotor is continuously running thus allowing the driving torque to be taken up gradually instead of a fraction of a second.

Any heating effect produced by the substantially dry running liquid ring pump on the air contained therein is conducted away by a continuous throughput of air drawn through from drain passage 24, rotating rubber lip seal 23 and out through outlet tract 22. The construction of the rotating rubber lip seal is such that under running conditions centrifugal force expands the seal's garter spring and allows the rubber lip to clear. When stationary the seal prevents leakage of water through drain passage 24. Alternatively it will be appreciated that the same effect would be achieved by incorporating a continuously running contact seal designed and manufactured to run dry together with a means whereby the small amount of heat generated within the liquid ring pump may be conducted away for example by a fluid cooled jacket.

Under running conditions, liquid from the liquid ring is prevented from spilling over to the drain passage 24 by integral back vanes 26 whose geometry is arranged such that the head produced by the back vanes exceeds the head produced by the blades of the rotor 25.

It will be appreciated that the non-return valve 4 performs no function in the priming process but has two secondary purposes. Firstly it prevents a centrifugal pump with a stationary impeller shaft, which has previously been primed, from losing its primed water back down the centrifugal pump inlet pipe, and secondly it enables the integrity of the various joints and seals of the centrifugal pump to be demonstrated by capping the centrifugal pump inlet, running the impeller shaft for a few momonts to establish a partial vacuum in the centrifugal pump casing and subsequently monitoring the rate of loss of vacuum from the centrifugal pump casing.

In a version not illustrated, the liquid ring pump may be manually brought into action by imposing a manual control on to the coolant circulation valve 12.

In a version not illustrated, the priming valve 5 may communicate with the suction side of the centrifugal pump and the non-return valve 4. Closure of the priming valve in this version would be effected by the outlet pressure from a centrifugal stage or by a float mechanism.

CLAIMS

1. A continuously driven liquid ring pump which is arranged to pump out its liquid ring and thereby run substantially dry when not in use.

2. A liquid ring pump as claimed in claim 1 wherein evacuation of the liquid ring is effected by closure of the port through which liquid coolant is admitted.

3. A liquid ring pump as claimed in claim 1 and claim 2 wherein the inlet port closure is effected by a valve.

4. A liquid ring pump as claimed in claims 1, 2 and 3 where the valve in claim 3 is manually operated.

5. A liquid ring pump as claimed in claims 1, 2 and 3 where the valve in claim 3 is operated by independent fluid pressure.

6. A liquid ring pump as claimed in claims 1, 2, 3 and 5 where the independent fluid pressure is the outlet pressure of a centrifugal pump stage.

7. A liquid ring pump as claimed in claims 1 and 2 wherein the inlet port closure is effected by a float mechanism.

8. A liquid ring pump as claimed in claim 1 and claim 2 is provided with a resistive port and rapid fill valve connected in parallel between a fluid reservoir and the valve specified in claim 3.

9. A rapid fill valve as claimed in claim 8 which is arranged to close when the liquid ring casing contains sufficient liquid to form a liquid ring and when the liquid ring pump is being continuously driven.

10. A rapid fill valve as claimed in claim 8 which is arranged to open when the liquid ring pump drive shaft is stationary.

11. A rapid fill valve as claimed in claim 8 which is arranged to open when the continuously driven liquid ring pump is running sub-

stantially dry and not in use.

12. A rapid fill valve as claimed in claim 9 wherein the valve closure member is a disc on a valve rod subject firstly to a spring force resiliently biased to open the liquid flow path through the valve and secondly to a closing thrust produced from fluid pressure conveyed through a duct from the liquid ring casing.

13. A liquid ring pump as claimed in claim 1 wherein the liquid from the liquid ring is pumped out through a resistive tract to a fluid reservoir.

14. The outlet of the tract into the fluid reservoir as claimed in claim 13 is arranged to be above the level of liquid in the reservoir by virtue of a suitable overflow duct located below the level of the outlet of said tract.

15. A centrifugal pump priming system comprising an impeller pump, a first duct connecting the outlet side of the impeller pump or the outlet side of one impeller stage of the pump to the inlet of a priming valve body, a second duct connecting the outlet of the priming valve body to the inlet of a non-return valve and a third duct connecting the outlet of the non-return valve to the inlet tract of the liquid ring pump as claimed in claim 1.

16. A centrifugal pump priming system comprising an impeller pump, a first duct connecting the intake side of the pump to the inlet of a priming valve body, a second duct connecting the outlet of the priming valve body to the inlet of a non-return valve and a third duct connecting the outlet of the non-return valve to the inlet tract of the liquid ring pump as claimed in claim 1.

17. A liquid ring pump substantially as hereinbefore described with reference to the accompanying drawing.

18. A centrifugal pump priming system substantially as hereinbefore described with reference to the accompanying drawing.

CLAIMS

Amendments to the claims have been filed, and have the following effect:-

Claims 1, 2, 4, 5 and 6 above have been deleted or textually amended.

New or textually amended claims have been filed as follows:-

1. A continuously driven liquid ring pump priming device for a centrifugal pump is arranged to automatically pump out its liquid ring on completion of the priming process, by providing for the outlet pressure of a centrifugal pump stage to effect closure of the port through which liquid coolant is admitted into the liquid ring pump, thus allowing said liquid ring pump to run substantially dry when not in use.

2. A liquid ring pump as claimed in claim 1 wherein closure of the port through which liquid coolant is admitted into the liquid ring pump is actuated by a fluid pressure which is dependent on the outlet pressure from a centrifugal pump stage.

Claims 8-18 above have been re-numbered as 4-14 and their appendancies corrected.

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